

A grayscale microscopic image of plant tissue, likely a leaf, showing a prominent circular lesion in the center. The lesion has a dark, irregular border and a lighter, textured interior. Several long, thin, curved structures, possibly veins or cell walls, radiate from the lesion across the frame. The background is a light gray with a fine, grainy texture.

Advances in Soil BORNE PLANT DISEASES

Editors: M. K. Naik and G. S. Devika Rani

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**Dedicated to the great teachers and
researchers in Plant Pathology**

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FOREWORD

With great pleasure I browsed through the book entitled “Advances in Soil Borne Plant Diseases” edited by Dr. M. K. Naik, Professor and Head and Ms. Devika Rani. G. S. of the Department of Plant Pathology, UAS, College of Agriculture, Raichur, Karnataka. Various aspects of soil borne plant diseases covered in the book on the recent developments in the field of molecular detection, genomics, plant growth promoting rhizobacteria mediated strategy, advances in use of biological control, *Trichoderma*, commercial production, formulation, registration and quality control and use of *Pseudomonas* are extensively presented to enlighten the readers. Several specific and non-specific soil borne pathogens such as *Fusarium*, *Sclerotium*, *Verticillium*, *Rhizoctonia* and *Phytophthora* have been dealt with elegantly. Adequate focus is on wheat, cotton and temperate fruits that badly suffer from soil borne diseases. Management of endoparasitic nematodes such as *Meloidogyne* spp and *Heterodera* spp, the hidden vectors and parasites have been adequately covered along with other group of nematodes. Solarizations, use of mycorrhizae as a biological deterrent of plant pathogens have been duly emphasized.

This “Advances in Soil Borne Plant Diseases” would serve as a comprehensive and critical review on different facets of soil borne plant diseases. The contributors of several chapters and specially the editors deserve the appreciation for brining the information on a single platform.

Hopefully, this book would serve as a reference source and help students, teachers, researchers and extension workers dealing with soil borne plant diseases. I compliment Dr. M. K. Naik and Ms. Devika Rani. G. S. for their efforts and keen desire to provide yet another aid in understanding soil borne plant pathogens.

Dr. S. Nagarajan

Chair person
Protection of Plant Varieties &
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MESSAGE

The food production has remained stagnant but the challenge before agriculture scientists is to achieve food and nutritional security to the burgeoning population. The plant protection specialists have to play a pivotal role in feeding the increasing number of hungry mouths. Perhaps, the foliar diseases and the above ground symptoms of the plant were the first to get attention of researchers and as a result they are much better understood than many soil borne diseases. The kind of complexities and intricacies involved in soil along with the living parameters such as pathogen is beyond comprehension compared to foliar diseases. However, the modern agriculture and horticulture practices encourage monoculture in which the same crop is planted repeatedly leading to increased soil sickness by plant pathogenic fungi and bacteria. While there are many books available on plant diseases dealing with foliar and above ground maladies but there are very few books and volumes exclusively on soil borne plant diseases. In this regard, the initiation taken by the editors of this volume "Advances in Soil Borne Plant Diseases" deserves special appreciation in bringing together the leading experts on one platform to review and synthesize the progress made so far and to evolve the future strategies on soil borne diseases.

There are seventeen chapters in the present volume dealing with various facets of soil borne plant diseases. The book begins giving a fine overview of many soil borne plant pathogenic genera highlighting the ecological principles, the importance of disease resistance and rhizosphere manipulation. The genera of soil borne fungi such as *Sclerotium*, *Rhizoctonia*, *Phytophthora*, *Fusarium*, *Verticillium* and endoparasitic nematodes are extensively dealt with. Advances made in bio-control particularly *Trichoderma* and *Pseudomonas*, their commercial mass production, registration, quality control and the priorities for research are discussed in a befitting way. The technological feasibility of soil solarization its refinement and integration with other techniques, use of mycorrhizae for

eco-friendly, sustainable management of diseases are extremely important and relevant topics presented in detail. The philosophy of integrated management of diseases and their long term effects in bringing down the inoculum below target level are given due consideration in the volume. Major soil borne diseases of important crops namely *viz.*, temperate fruit crops, wheat and cotton have been dealt at length.

The book provides a very comprehensive and critical review on different aspects of soil borne plant pathogenic fungi including the molecular detection and characterization. Of late, such molecular tools have an immense potential for detection of soil borne fungi wherever they are not accessible for morphological detection. The genomics of some important bio-control agent such as *Pseudomonas fluorescens* has been emphasized along with gene based detection of antibiotic production which is essential to further explore the bio-control potentiality. We are in an exciting era of biological revolution where genes can be transferred horizontally from one species to another. Inclusion of chapters on genomics of bio-control agents, PGPR mediated resistance, molecular detection *etc.* are very relevant and timely to the current trends of plant disease management applicable to soil borne plant pathogens. I hope the efforts of the editors will certainly enlighten the readers on soil borne plant diseases. I am extremely happy that many authors have consulted the recent literature in presenting various chapters. My heartiest congratulations to the editors for taking all the pain in bringing out this volume on poorly understood group of pathogens in a most presentable form for the readers. The teachers, researchers and students are likely to be benefited by this volume in evolving newer dimensions for research on soil borne plant pathogens. My felicitation to the editors for the wonderful job they have done by presenting this volume.


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PREFACE

Ever growing population, the increased awareness for quality food, dwindling land resource, environmental pollution of mother planet, resistant to chemicals in pathogen population are some of the grave problems faced by the mankind. Need of food for billions in future is a challenge to agricultural professionals including plant pathologists. Further exploitation of hybrid vigor will be a difficult venture in many crops. In this connection, plant protection specialists have to play a vital role in protecting plants and avoiding food losses.

Most obvious diseases such as foliar diseases were studied first unlike their counterparts; soil borne plant diseases which are generally less understood. The soil is much more complex chemically, biologically and physically than the atmosphere above the ground. There exist many intricacies and complexities in rhizosphere, fungistasis, microbial interaction and bio-control processes to a greater extent in soil borne plant pathogens compared to aerial/foliar pathogens. Soil borne plant diseases will continue to be a hazard both in field and horticultural crops, which have been documented through out the history of mankind. Monoculture has become the feature of modern agriculture. Crop plants tend to be produced commercially where they are best adopted and are planted repeatedly in such sites. Crops such as banana, tomato, cotton, tobacco, cucurbits, pigeonpea, chickpea and wheat have suffered the onslaught of soil borne plant pathogens. If a soil borne pathogen is present and favored by that particular environment, the soil infestation increases rapidly. In the absence of proper management much of the best suited land for the crop is lost.

This book makes an attempt to bring together information on soil borne plant diseases which include root rot, crown or collar rot, damping off, wilts, blights in field and horticulture crops. Soil borne plant diseases taken together cause a tremendous loss in world agriculture. Their destructiveness is basically due to their ability to survive for several years in soil as dormant structures like sclerotia, chlamydospores, macroconidia and resting mycelia and they withstand the adverse environmental conditions. Due to substantial losses caused by soil borne plant diseases a thorough understanding of their biology, perpetuation, population dynamic, ecology and molecular aspects of soil borne plant pathogens is essential.

Understanding the nature of soil borne pathogens will also help in determining what opportunities are available for its management. Mode of their survival and

dissemination, effect of environment on diseases, problems of host resistance, the role of cultural practices, biological control and the use of novel molecular approaches wherever appropriate are some of the aspects dealt in this volume. The book contains seventeen chapters covering various facets of soil borne plant diseases.

The first chapter gives an overview of soil borne plant pathogens such as *Fusarium*, *Verticillium*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, *Sclerotium*, *Phytophthora* and *Macrophomina*. The chapter also highlights the ecological and epidemiological tools essential and various approaches for management including rhizosphere manipulation and disease resistance. The book includes three separate chapters on important genera of fungi namely *Rhizoctonia*, *Sclerotium* and *Phytophthora* (chapters 2nd, 4th and 16th). *Rhizoctonia solani*, a soil inhabiting non-specialized pathogen without any exploitable resistance available among crop species, can only permit some control through cultural practices disadvantaging pathogen by reducing inoculum potential. The chapter on *Sclerotium rolfii* deals about the morphological and genetic variations, sclerotial biogenesis, mycelial compatibility group, recovery of sclerotia and their management. Molecular detection and characterization of soil borne fungal plant pathogens by using chromosome and nucleic acid based technique has been included in the third chapter. Since serological methods are difficult in fungi due to their complex and variable nature of antigens, the techniques like DNA probes can be used in those fungi which are not accessible for morphological detection. Plant growth promoting rhizobacteria mediated disease management strategy has been dealt in chapter five, where as a discussion on genomics of *Pseudomonas fluorescens*, a versatile and most worked out PGPR, along with its biocontrol potential and gene based detection of antibiotic production has been highlighted in sixth chapter. Considering the importance of crops such as wheat, temperate fruits and cotton with respect to soil borne diseases, the editors have included 7th, 8th and 9th chapters respectively on these crops. Soil borne diseases have become a matter of great concern even in crops like wheat due to monoculture and hence major soil borne diseases of wheat such as karnal bunt, blights, flag smut, *Fusarium* head scab, foot and root rot diseases are described in a separate chapter. Cotton has suffered a great loss due to soil borne disease since early days of its cultivation and hence, wilt diseases of cotton have been described in chapter nine. Endoparasitic nematodes particularly *Meloidogyne* spp. and *Heterodera* spp., which are our hidden enemies, have found a place in chapter eleven with emphasis on non-chemical management strategies. Lesion nematode, *Pratylenchus* species, their biology and management has been given adequate attention through chapter fourteen. Use of on-farm wastes such as cruciferous residues combined with sublethal heating to weaken the survival structures of fungi for managing soil borne plant diseases particularly in hot arid

region is extensively covered in 12th chapter. The last decade has witnessed a tremendous break-through in research efforts on bio-control especially using *Trichoderma* species. The potential of *Trichoderma* species, various diseases it can control, improvement of *Trichoderma*, the mechanism involved, induced resistance, commercial mass production, formulation, registration, quality control, R and D priorities are reviewed in chapter thirteen. Soil solarization is gaining popularity in more than fifty tropical countries of the world as a viable technology due to growing concern about pesticide residue in food and drinking water. The fifteenth chapter dwells on the principles of solar heating, mechanisms involved, other beneficial effects, limitations and refinement of solarization technology for management of soil borne diseases. Mycorrhizae are equally gaining importance in suppressing soil borne plant pathogens which are essential in sustainable disease management, which has been presented in chapter ten. Lastly, a chapter on integrated management of soil borne diseases has been added emphasizing the philosophy of IDM in an ecologically sound manner with due consideration to economic, social, legislative parameters and usefulness in reducing the quantity and effectiveness of primary inoculum to reach the target of low disease in the crop.

This book is brought out to serve the researchers, extension workers, teachers, post graduate students, scientists and students of general plant pathology, microbiology, microbial ecology, biological control and molecular biology on the current knowledge of soilborne plant diseases. The book chapters with diversified ideas and from different groups are organized systematically to the best of our knowledge.

The publication of this book would not have been possible without the sincere cooperation and the hard work of the contributing authors who are not only specialists in their respective fields and also leaders in their own right from national educational centers, laboratories and universities. Therefore, we have tried to honor their ideas in the original shape. In dealing with such a voluminous task, errors are likely to creep in inspite of our best efforts. However, the onus of the technical contents rests with the contributors. We place on record our reverence and gratitude to all the learned contributors for the cooperation in compiling a very useful information on different aspects of soil borne plant diseases. We are also sure this detailed account on a wide variety of subject concerning soil borne plant diseases would benefit the researchers and teachers for planning future strategies for researching on soil borne plant pathogens.

We are grateful to the Honorable Vice-chancellor, University of Agricultural Sciences, Dharwad and Director of Instruction (Agri.), College of Agriculture, Raichur for providing facilities during the compilation of the book. The senior editor would like to thank his wife Uma, daughter ShreeRaghavi and son ChinmayaKrishna, for their unstinted support, calm inspiration and buoyant

temperament in many invisible ways in completion of the task undertaken. The second editor wishes to thank her parents and family members for the kind support and encouragement received during the period. We are extremely thankful to colleagues, staff members and PG students for their help rendered during the preparation of this volume. We gratefully acknowledge the efforts of Mr. G. Earanna for neat typing. We highly appreciate the all-round cooperation and support from the entire staff of New India Publishing Agency, New Delhi for printing and publishing this book with utmost patience and care.

September, 2007
Raichur

M. K. Naik
G. S. Devika Rani

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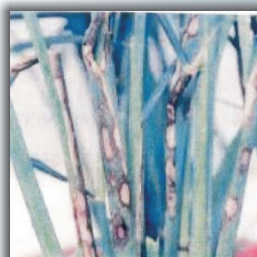
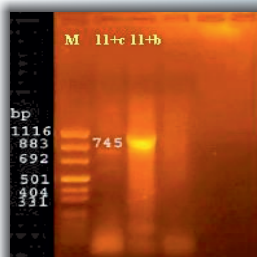
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Advances in Soil Borne Plant Diseases

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This book is an attempt to provide critical and up-to-date review and synthesis of various facets of soil borne plant diseases taking stock of present state of art in soil borne plant pathogens. The contributors from various national laboratories, centres of excellence in research institutes and university with mastery over the subjects illustrate and review the progress, application of knowledge on soil borne plant diseases besides updating the readers with recent paradigm shift in soil borne plant diseases taking in to account the art and science of ecology and epidemiology, disease resistance, physico-chemical and biological aspects of solarization, bio-control processes, molecular detection, genomics of bio-control, PGPR activity and the art of managing soil borne diseases in a sustainable way. The book also comprises special chapters on typical major soilborne fungal genera such as *Rhizoctonia*, *Fusarium*, *Verticillium*, *Phytophthora* and *Sclerotium* besides endoparasitic nematodes, *Heterodera*, *Meloidogyne* their biology, perpetuation and population dynamics and the topics on soilborne diseases of important crops like wheat, cotton and temperate fruits add to the importance and utility of the volume. The recent development in bio-control, mass production, registration, quality control, the principles of solar heating, use of mycorrhiza, utilization of on-farm wastes combined with sublethal heating and its utility in hot arid region are some of the special features of the volume. The philosophy of IDM with due consideration to ecology and economic parameters have been covered. The book caters the need of knowledge hungry students, teachers, researchers, policy makers, extension workers of general plant pathology, microbiology, microbial ecology, biological control, molecular biology, general biology and all well wishers of farmers.

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